VOLUMINOUS NON-WOVEN FABRIC

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a voluminous non-woven fabric that has a textured yarn shot through it, at least in one preferential direction.

Description of Related Art

Cloths made of non-woven fabric, with a mass per unit area of about 25 to 50 g/m^2, are known from the document U.S. Patent 4,623,576; they possess good absorption properties and are particularly intended for wiping up oil, food residues, or wiping off electronic parts. Absorbent wiping cloths made of non-woven fabrics for one-time use (disposables) are used in the hygiene, cosmetics, and medical sectors, and are made either of so-called air-laid non-woven fabrics or of non-woven fabrics entangled using jets of water. They are often impregnated with fluids that contain skin-care substances.

Air-laid non-woven fabrics are understood to be those non-woven fabrics whose fiber components are uniformly mixed with one another in an air stream, and deposited on a screen. The components of such an air-laid non-woven fabric have relatively short fibers. In this connection, dusts and components with a fibrid structure, such as cellulose and/or synthesis pulp (viscose staple fiber) are also used, at least in part. Bonding of the air-laid non-woven fabric to produce a structural integrity that is suitable for use is performed using the known methods of adhesive bonding using polymer dispersion and/or the use of hot-melt fibers or adhesive fibers. A disadvantage of these non-woven fabrics composed of short fibers is that when using a comparable amount of binder as in carded non-woven fabrics, the strength obtained is

clearly lower. Air-laid non-woven fabrics that are used as wiping cloths in hygiene, cosmetics, or medical applications demonstrate significant disadvantages with regard to their softness and feel, even in the moist state, because of their similarity to paper, in terms of process technology, and, in particular, if high proportions of cellulose fibers are used.

The second class of absorbent non-woven fabrics for absorption and wiping purposes are those whose fibers were generally entangled fully free of binder, exclusively using high-pressure water jets, i.e. hydrodynamically. Fiber materials used here are mixtures of hydrophilic fibers, such as viscose rayon, lyocell, cotton, viscose staple fiber, and fully synthetic fibers, such as polyester or polypropylene. The absorbent non-woven fabrics do possess very great structural integrity (strength), but only a slight material thickness, in other words a high material density, and, connected with this, a low absorption capacity per mass per unit area. For the air-laid non-woven fabrics and hydraulically entangled non-woven fabrics as described, it is known to provide their surface with a certain texture, but nevertheless these non-woven fabrics demonstrate only a relatively flat, two-dimensional structure for use as wiping cloths in hygiene or medical applications. In particular, when used for a wiping process for the removal of dirt particles, such as wiping excrements off human skin, for example, these particles are merely shifted around on the surface and not absorbed by the wiping cloth.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a voluminous non-woven fabric that demonstrates very good sensory properties and textility both with regard to softness and drapability, even in the non-fluid-absorbent state.

This and other objects of the invention are achieved by a voluminous non-woven fabric that has a textured yarn shot

through it in at least one preferential direction, where an endless filament and/or staple fiber non-woven fabric with a mass per unit area of 5 to 100 g/m² has a textured multifilament yarn with a titer in the range of 10 to 400 dtex shot through it, where the distance of the multifilament yarns from one another is 1/cm to 10/cm, and the mesh number is 0.5/cm to 8/cm, and the multifilament yarn threads are shrunk by 3 to 80%, using moist-thermal or wet-thermal treatment. The length reduction of the multifilament yarn in the non-woven fabric through which it is shot is brought about by supersaturated steam or by hot air streams, where low-contact or contact-free shrinkage conditions are chosen, if at all possible. Furthermore, the basic non-woven fabric can have yarn shot through it both in the machine direction (warp direction) and in the crosswise direction (weft direction). Textured multifilament yarns can be used in both directions. For cost reasons, however, it is advantageous to use textured multifilament yarns only in the one preferential direction, and to use non-textured multifilament yarns or even more cost-effective monofilaments in the other direction. However, particularly voluminous structures are achieved only with textured multifilament yarns shot through absorbent non-woven fabrics in the warp direction.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described in greater detail with reference to the following drawings wherein:

Figure 1 is a schematic representation of a voluminous non-woven fabric according to the present invention,

Figure 2 is a cross-section of a non-woven fabric according to the present invention, along Line A-A of Figure 1, on a larger scale, and

Figure 3 is a cross-section of a voluminous non-woven fabric with an asymmetrical undulation.

DETAILED DESCRIPTION OF THE INVENTION

The voluminous non-woven fabric according to the present invention demonstrates a wave-like buckled structure and therefore a ridge and groove shape of the surface structure formed as a result, thereby improving the wiping effect and the dirt holding capacity, particularly between the ridges. An absorbent disposable cloth that is soft and flexible and expandable in at least one direction is produced, which has a high level of structural integrity in spite of its high absorption capacity.

Preferably, the voluminous non-woven fabric is one in which an endless filament and/or staple fiber non-woven fabric with a mass per unit area of 7 to 60 g/m^2 has a textured multifilament yarn with a titer in the range of 30 to 300 dtex shot through it, where the distance of the multifilament fibers from one another is 3/cm to 7/cm, and the mesh number is 0.5 to 4 per cm, and where the multifilament yarn threads have been shrunk by 5 to 60%, using moist-thermal or wet-thermal treatment. If textured yarns are shot through in a preferential direction, this simultaneously means an area shrinkage in this preferential direction. At a 90° angle to this preferential direction, no shrinkage occurs. However, if textured yarns are shot through in both directions, their length reduction in the warp and weft direction is determined by the number of yarns in the preferential direction per length or width unit, their total titer, their degree of texture, and their chemical composition.

Mesh number is understood to mean the number of stitches (needle stitches) in the warp direction. The warp-worked yarns are preferably structured to be linear. However, they can also be sewn in in zig-zag shape in the warp direction.

The raschel-worked absorbable non-woven fabrics are subsequently subjected to a shrinkage process, in such a manner that the non-woven fabric itself does not experience

any area reduction, rather the textured yarns that are shot through only experience a shortening of their expanse. This results in a partial re-orientation of the absorbable non-woven fabric into the third dimension. The preferential direction of the textured yarns determines the geometry of the three-dimensional structure, as does the fact whether these yarns are shot through in two preferential directions.

The textured multifilament yarns can be made of the same or two different homofilaments or bicomponent filaments. Possible polymer materials for the textured threads are all of those that are in keeping with the state of the art, such as polyamide 6, polyamide 6.6, polyethylene terephthalate, polybutylene terephthalate, copolyesters of many different compositions, mono- or multicomponent polyolefins and/or polyolefins catalyzed with metallocene. Likewise, biodegradable thermoplastics, such as polyester amides or copolyesters based on terephthalic acid and adipinic acid, with aliphatic and cycloaliphatic diols, such as those described in WO 96/255446, German Patent 44 40 858, and German Patent 195 185, can be used as the basis for the textured yarns.

Such a non-woven fabric has proven to be particularly soft and flexible, whereby a wiping cloth that demonstrates a high absorption capacity and a high level of structural integrity is obtained.

A voluminous non-woven fabric in which an endless filament and/or staple fiber non-woven fabric with a mass per unit area of 10 to 40 g/m^2 is provided with a bonding pattern that covers part of the surface, covering 2 to 35% of the surface, and with a multifilament yarn, where the multifilament yarn threads are shrunk by 8 to 35%, is especially preferred. The bonding over part of the surface can be brought about by heat and pressure, by ultrasound bonding, or by adhesive bonding, using rotogravure or screen printing. In an especially

preferred embodiment of the invention, needle-punched non-woven fabrics are used as the basic surface, where hydrodynamic entangling with high-pressure water jets, as compared with mechanical needle-punching using a needle loom, is preferred.

It is advantageous if the voluminous non-woven fabric is one where the bonding pattern that covers part of the surface covers 4 to 25% of the surface. This results in very good structural integrity.

A voluminous non-woven fabric in which the titer of the fibers and/or filaments of the non-woven fabric being used lies between 0.05 and 4.4 dtex, where up to 20 % by weight of the fibers and/or filaments can have a coarser titer than 4.4 dtex, subject to the condition that the arithmetically determined average of the fiber and/or filament titer of all the fibers and/or filaments in the non-woven fabric does not exceed 4.4 dtex, is especially preferred. In the case of fiber and/or filament titers below 0.8 dtex, these are fibers or filaments that were produced using the so-called melt-blown process, or so-called multicomponent split fibers, which have a titer of more than 0.8 dtex before splitting, and a fraction of that titer after splitting. Splitting preferably takes place using high-pressure water jets. However, splitting can also take place using a mechanical softening or microcrepe process (micrex), as described in the document EP 0 624 676, or using treatment with hot steam or hot water, in accordance with the methods explained in the document U.S. 5,759,926 for spun non-woven fabrics or in accordance with the methods explained in the document EP 0 864 006 for microfiber melt-blown filaments. The hydrophilic spinning mass or the more hydrophilic of the two spinning masses can have an ethoxylated polysiloxane added to it as a hydrophilization agent, in an amount of approximately 1 - 5 % by weight, to facilitate splitting or to increase the incompatibility of the two polymers used in the splitting phase. All of the known fiber

and/or filament cross-section shapes can be used for the voluminous non-woven fabric according to the present invention. Examples are round, oval, square and/or trilobe shapes. Furthermore, fibers and/or filaments with channel-like recesses in their surface are also included. The split microfibers and/or filaments normally have a cross-section with the shape of pieces of cake.

Preferably, the voluminous non-woven fabric is one where the temperature that triggers shrinkage of the multifilament yarn lies approximately 25 °C below the plastification temperature of those fibers and/or filaments in the non-woven fabric with the lowest plastification point. In a normal case, the non-woven fabric carrier through which the multifilament yarn is shot does not suffer any area shrinkage. According to the present invention, the length reduction of the textured multifilament yarn is greater than the area reduction of the non-woven fabric due to inherent shrinkage in the direction of the multifilament yarn that is shot through. The fiber pile can also have a proportion of shrinkage fiber, such as physically modified polyester average-shrinkage fibers or polyester high-shrinkage fibers, added to it. In this connection, the proportion of these shrinkage fibers is selected to be so low that during the shrinkage process, the area shrinkage of the non-woven fabric in the preferential direction in which the multifilament yarn is shot through is lower than the reduction in length of the multifilament yarn. The polyester shrinkage fiber proportion in the non-woven fabric lies in the range of 3 to 40 % by weight, preferably in the range of 5 to 25 % by weight. With this additive, the integrity of the non-woven fabric with the multifilament yarn shot through it can be additionally increased, thereby improving the friction wear resistance during the wiping process.

A voluminous non-woven fabric where the non-woven fabric is stretched crosswise to the machine direction is especially

preferred. Re-orientation of the basic non-woven fabric into the third dimension can be reinforced in that stretching of the non-woven fabric with the multifilament yarn shot through is stretched crosswise to the machine direction. For this purpose, the known methods for crosswise stretching of flat structures can be used, but stretching by passing the non-woven fabric with the multifilament yarn shot through over stretching rollers is preferred, since this process is particularly gentle on the material, in contrast to the use of stretching frames, and results in a uniform distribution of the crosswise forces over the width of the textile web. Furthermore, by stretching the non-woven fabric in the crosswise direction, it is possible to partially eliminate or loosen up bonds or reciprocal mechanical anchor points of the fibers and/or filaments, thereby achieving an additional significant increase in the softness and flexibility of the voluminous non-woven fabric according to the present invention. An additional effect of stretching the non-woven fabric in the crosswise direction is the greater area of the finished material, which is proportional to the stretching factor, and thereby an economically efficient increase in the productivity of the overall process. In this connection, the stretching factor is defined as the quotient of the width of the textile web after the stretching process and the width of the textile web before the stretching process.

Preferably, the voluminous non-woven fabric is one where approximately 20% by weight of the fibers and/or filaments are inherently hydrophilic, and the remaining portion are synthetic fibers and/or filaments, totaling 100% by weight. The starting fibers and/or filaments for the non-woven fabric can consist of one or more components. In this connection, a proportion of approximately 20% by weight of those fibers and/or filaments that are permanently hydrophilic are used. The hydrophilia of the fibers and/or filaments can be polymer-inherent, as is the case, for example, for fibers on a cellulose basis or polyamide basis. However, it can also be

brought about by the addition of a hydrophilization agent to the melt of the polymer that forms the fibers, before it is spun. According to the present invention, the term "permanently hydrophilic" means a fabric made of fibers and/or filaments where the hydrophilization components reach the fiber surface, from the fiber interior, by migration, during storage. Fibers with "inherent hydrophilia" are preferably viscose rayon staple fibers, for example from cellulose fibers spun in solution in N-methyl morpholine-N-oxide (lyocell, cotton, or viscose staple fibers). The lyocell fibers can be smooth or crimped. According to the present invention, proportions of less than 20% by weight inherently hydrophilic fibers can also be used, but there is the risk that in the case of a folded wet wipe cloth that is folded and stacked, the aqueous emulsion for skin care with which the cloth is impregnated will accumulate in the bottom layers during storage. As a tendency, this would cause the top layers to dry out, and thereby have a detrimental effect on their wiping properties as well as the release of skin-care substances during the wiping process.

A voluminous non-woven fabric where at least part of the synthetic fibers and/or filaments are made to be hydrophilic is especially preferred. The not inherently hydrophilic fibers and/or filaments that make up the remaining portion of fibers and/or filaments, totaling 100% by weight, are preferably of an entirely synthetic nature. In the case of endless filaments, these are subsequently made hydrophilic, in the non-woven fabric, using known surfactant substances. In this connection, the adhesion of externally applied hydrophilization agents and the duration of the hydrophilic effect are decisively determined by the chemistry of the surfactant agent used, and the surface properties of the fiber and/or filament material.

Preferably, the voluminous non-woven fabric is one that contains at least a proportion of superabsorbent fibers and/or

filaments or fibers and/or filaments whose core is coated with a superabsorbent polymer. The use of superabsorbent fibers and/or filaments or fibers and/or filaments coated with superabsorbent polymer improves the absorption capacity of the non-woven fabric according to the present invention.

Preferably, the voluminous non-woven fabric is furthermore one that contains crimped and dyed fibers and/or filaments. The fibers or filaments of the non-woven fabric can be smooth or crimped in two or three dimensions, or crimped fibers or filaments can be mixed with non-crimped ones. Preferably, however, crimped fibers or filaments are used, since these improve the absorption capacity. Depending on the purpose of use, the fibers and/or filaments can be colorless or dyed in the spinning mass with dye and/or white pigment. In this connection, part of the fibers can be textile-dyed before or after formation of the non-woven fabric, or after completion of the shrunk voluminous non-woven fabric with the multifilament yarn shot through.

Preferably, the voluminous non-woven fabric is one that is impregnated with a lubricant such as silicone oil. Furthermore, the non-woven fabric can additionally contain a proportion of siliconized fibers or fibers with other lubricants. However, the lubricant can also be applied to the non-woven fabric afterwards, either after it is formed or after it is bonded to produce a flat textile structure. By applying a lubricant such as silicone oil, for example, to the fibers and multifilaments of the non-woven fabric before shooting a multifilament yarn through it, the friction of the sewing needles against the non-woven fabric when the multifilament yarn is shot through can be reduced.

A voluminous non-woven fabric that has two different sides, in terms of their composition and/or their structure, is especially preferred. For this purpose, the non-woven fabric is composed of several different fiber and/or filament layers,

which have been joined together to form a composite, even before the multifilament yarn is shot through, using known bonding techniques. By using different fiber or filament layers on the two main sides of the voluminous non-woven fabric, different fluid absorption and wiping properties can be achieved, and they can be used accordingly. For example, by using a voluminous non-woven fabric with different sides, a differentiation can be made between pre-cleaning and subsequent cleaning. Furthermore, in this way it is easier for the user to differentiate, optically and via other sensory properties, which side of the non-woven fabric according to the present invention is supposed to be used for the absorption of dirt particles and therefore for an optimum wiping effect.

A voluminous non-woven fabric that is folded once or several times is especially preferred. The folded shape is used for wiping, cleaning, and body care purposes. Volume-stable disposable cloths with a very great absorption capacity are obtained, particularly in folded form.

A voluminous non-woven fabric that is impregnated with a cleaning or care emulsion is especially preferred. Preferably, aqueous emulsions, for example, are applied to the voluminous non-woven fabric for this purpose. Furthermore, after shrinkage, binders can be applied on one or both sides, using known methods. For this purpose, aqueous synthetic dispersions are preferably used, with wetting agents and/or hydrophilizing polymers added to them to improve their hydrophilic properties. The binder can additionally be used as a carrier for color pigmentation, such as a white pigmentation of the product, for example. Furthermore, abrasive, inorganic particles such as corundum can also be added to the binder, in order to achieve an abrasive effect during the wiping or cleaning process, at least on one side. In this case, the polymer dispersions used are those that result in a very hard film. In this connection, the polymer binder can also be

applied using a full-bath dipping process.

The voluminous non-woven fabric according to the present invention is preferably used as a wiping, cleaning, or body care cloth.

Figure 1 schematically shows a voluminous non-woven fabric 1 according to the present invention, where the original non-woven fabric 2 has been buckled to form waves 3, which are composed of elevations 4 and valleys 5. Direction A-A represents the machine direction or warp direction. Multifilament yarns 6, which are oriented in the warp direction, textured, and shrunk, are shot through non-woven fabric 2 at positions 7, and form stitches 8. Regions 9 of multifilament yarn 6, between stitches 8, i.e. between positions 7, which regions are oriented in direction A-A, are elastic.

Yarn regions 9 shown in Figure 2 are composed of multifilament threads 6 that have been strongly textured using shrinkage, with a structure similar to spiral springs, giving the product outstanding softness and elasticity. Non-woven fabric 2 with its waves 3, composed of elevations 4 and valleys 5, is preferably made up of crimped fibers 10, which have been intensively entangled using water jets. Figure 2 shows the case of a symmetrical undulation 3, where yarn regions 12 and 13 on the right and left of maximum height 11 of waves 3 each make up half the length of yarn region 9. In this connection, maximum wave height 11 is defined as the distance of yarn region 9 from elevations 4 of waves 3.

Figure 3 shows an asymmetrical undulation 3 of non-woven fabric 2, where maximum height 11 of waves 3 is shifted in the direction of one of yarn regions 12 or 13. Such a case can occur if the voluminous non-woven fabric is pressed or subjected to friction after the shrinkage process.

The textured threads wound up on warp beams are shot through the non-woven fabric using known methods, preferably only in the warp direction, where the limits and gauges already described above must be adhered to with regard to non-woven fabric parameters (weight, structure, pre-bonding method, etc.) and working parameters (type of textured yarns, total titer in dtex, mesh number/cm).

After the textured multifilament yarns are shot through, the flat structure is exposed to moist treatment for shrinkage, in supersaturated steam in boiling or almost boiling water, or to hot-water treatment in a pressure container (for example similar to a textile polyester dispersion dyeing process). Temperatures above 100 °C are suitable, but they are less preferred for cost reasons.

The selection of the temperature for yarn shrinkage in the flat structure is based on the composition of the non-woven fabric and the textured multifilament yarn. The temperature and its dwell time are preferably selected in such a way that the non-woven fabric itself is not subject to any area shrinkage, and it is exclusively the textured yarn that suffers a reduction in length due to shrinkage. Therefore not only should the textured multifilament yarns used preferably be composed of filaments that have a relatively high melting point or plastification point, such as polyethylene terephthalate, polybutylene terephthalate, polyamide 6, or polyamide 6.6, for example, or bicomponent yarns made up of two of these fiber filaments, but also the fibers of the non-woven fabric should be composed of thermally stable fiber material. The wave-like structure that is necessary for the invention prohibits the use of the same polymer both in the non-woven fabric and in the textured yarn. Preferably, the fibers used in the non-woven fabric are also either not thermoplastic or they are fibers that do not decompose at the shrinkage temperature of the yarn, or fibers with a higher melting point, such as polyethylene terephthalate,

polybutylene terephthalate, polyamide 6, or polyamide 6.6, or bicomponent yarns made up of two of these polymers, or mixtures of the said fibers.

The flat goods are subsequently either folded in the dry state and/or provided with an aqueous care lotion impregnation, then folded into shape, and placed in hard, shape-stable and re-sealable plastic boxes ("dispenser box") as a stack, or a stack of several folded cloths is sealed into flexible plastic bags ("re-fill pack").

Example 1

A carded staple fiber pile composed of 60% viscose staple fiber dtex 1.5/40 mm and 40% polyester dtex 1.5/38 mm, based on polyethylene terephthalate, is placed on a conveyor belt and passed to the water removal screen of a high-pressure hydraulic entangling device. The metal screen has a fine mesh and has the mesh number 100. After being pre-wetted with water, the fiber pile is first treated on one side with aimed high-pressure water jets, then turned over and entangled on the other side with high-pressure water jets. Subsequently, excess water is suctioned off by passage through a vacuum slit, up to a residual moisture of 98%. Subsequently, drying takes place in a so-called belt dryer. On the winding apparatus, a mass per unit area of the hydraulically entangled non-woven fabric of 49 g/m^2 is obtained.

The hydraulically entangled non-woven fabric is shot through, in the warp direction, with textured polyester multifilament yarns, on a raschel machine. These yarns are composed of 36 individual filaments with an individual titer of 1.39 dtex, resulting in a total titer of 50 dtex for the yarn.

The yarns that are shot through in the warp direction have a mesh number in the warp direction (= machine running direction) of 2/cm. The number of yarns shot through parallel to one another is 18/inch (7.11/cm). The mass per unit area

after the multifilament yarns are shot through in the warp direction is 61.8 g/m².

In a third process step, the non-woven fabric with the multifilament yarn shot through is subjected to thermal shrinkage treatment at 140 °C, over a period of 20 seconds. Under these conditions, a reduction in the length of the textured yarns in the warp-shot non-woven fabric by 16% and an undulating structure of the latter are achieved. This results in a mass per area unit of 73.6 g/m².

Example 2

The composition of the hydraulically entangled non-woven fabric and the conditions of shooting through the textured polyester yarns, as well as their mesh number and yarn number per unit of length, are identical. The only difference is that instead of dry thermal treatment, moist thermal treatment with supersaturated steam at 125 °C and a dwell time of 20 seconds was carried out.

This results in clearly greater shrinkage in the machine running direction, in comparison with Example 1. At 24.5 % it had a clearly more pronounced wave structure than in Example 1. The width of the fabric remains unchanged, so that a total area shrinkage of 24.5% and a mass per unit area of 81.8 g/m² were obtained.

Example 3

The fiber mixture of the hydraulically entangled non-woven fabric produced in Example 1 was exchanged for one composed of 100% viscose staple fiber dtex 1.5/38 mm, and the dry weight after hydraulic entanglement was reduced from 49 to 20 g/m². After shooting through the yarn, as described in Example 1, steam shrinkage takes place as in Example 2. The mass per unit area after warp shooting is 32.2 g/m².

A shrinkage, i.e. length reduction in the flat goods of 50.3%

occurred, in the machine running direction. The finished material weight was 64.8 g/m^2.

Example 4

Endless filaments are extruded from the melt, quenched with cooling air streams, then stretched to a titer of 1.7 dtex using directed air streams, and then placed on a conveyer belt to produce a non-bonded endless filament non-woven fabric.

In cross-section, the endless filaments demonstrate a cake-like structure with a total of 16 pieces of cake, where larger and smaller pieces of cake alternate in a regular sequence. The larger pieces of cake are composed of polyamide 6.6, and the smaller ones of polyethylene terephthalate, so that the total of 16 pieces of cake are divided up into 8 large ones made of polyamide 6.6 and 8 small ones made of poylethylene terephthalate. The weight proportions of the so-called PIE fibers are 65% polyamide 6.6 and 35% polyethylene terephthalate.

An anti-static agent, i.e. a hydrophilization agent, was added to the spinning mass of the polyamide 6.6 portion.

The non-bonded endless filament non-woven fabric was passed to a hydraulic entanglement unit as in Example 1.

Here, high-pressure hydraulic entanglement resulted not only in intensive entanglement of the fibers with one another, but also in splitting of the fibers, up to a degree of splitting of approximately 93%. The degree of splitting was roughly determined by counting out the resulting microfibers under a raster electron microscope. The titer of the microfibers on the basis of polyamide 6.6 and polyethylene terephthalate is calculated at 0.138 dtex for polyamide 6.6 and 0.074 for polyethylene terephthalate with the pie configuration (16-part pie) and the total titer of the non-split endless filaments. The specific density of polyamide 6.6 is 1.14, and that of

polyethylene terephthalate is 1.37 g/m², resulting in a calculated fiber count of 3.92 μm for polyamide 6.6 microfibers, and 2.62 μm for polyethylene terephthalate microfibers.

After drying of the hydraulically entangled non-woven fabric that was split into microfibers, with a weight of 34 g/m², textured multifilament polyester yarns are shot through in the machine running direction, as described in Examples 1 - 3. Then the goods are subjected to contact-free, air-borne hot air treatment at 210 °C over a period of 10 seconds.

This resulted in undulation and a length shrinkage / length reduction of 32.2%. The mass per unit area of the finished material was 69.3 g/m².

Comparative Example A

Example 1 after hydraulic entanglement is used as Comparative Example A.

Comparative Example B

Comparative Example B corresponds to Example 1 after hydraulic entanglement, with the difference that instead of the fine 100 mesh screen in the hydraulic entanglement device, a coarse screen with 20 mesh was used. This resulted in a non-woven fabric with a perforated structure.

Test characteristic	Mass per unit area in g/m²	Thickness in mm		Water absorption in g/m²		HZK N/5 cm		Shrinkage in % lengthwise
		1-ply	4-ply	1-ply	4-ply	length wise	cross wise	
Example 1	73.6	1.84	7.12	863	3374	65.3	12.1	16.0
Example 2	81.8	1.93	6.93	952	3467	238	10.1	24.5

Example 3	64.8	2.07	7.98	935	3838	84.9	3.8	50.3
Example 4	69.3	1.87	7.05	289	1176	56.2	25.3	32.2
Example A	49	0.91	4.05	577	2366	79.1	16.3	0
Example B	54	1.04	4.36	542	2205	93.2	18.8	0

(HZK = maximum tensile strength)